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RLD 3-5-11

MODEL 1612/S1 PARALLEL FILTER

MODEL 1612/S2 SPECTRUM SHAPER

MODEL 1612/S3 PARALLEL ANALYZER

B & K INSTRUMENTS, INC.
Bruel & Kjaer Precision Instruments
3044 WEST 106th St. • CLEVELAND, OHIO 44111

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MODEL 1612/S1 PARALLEL FILTER

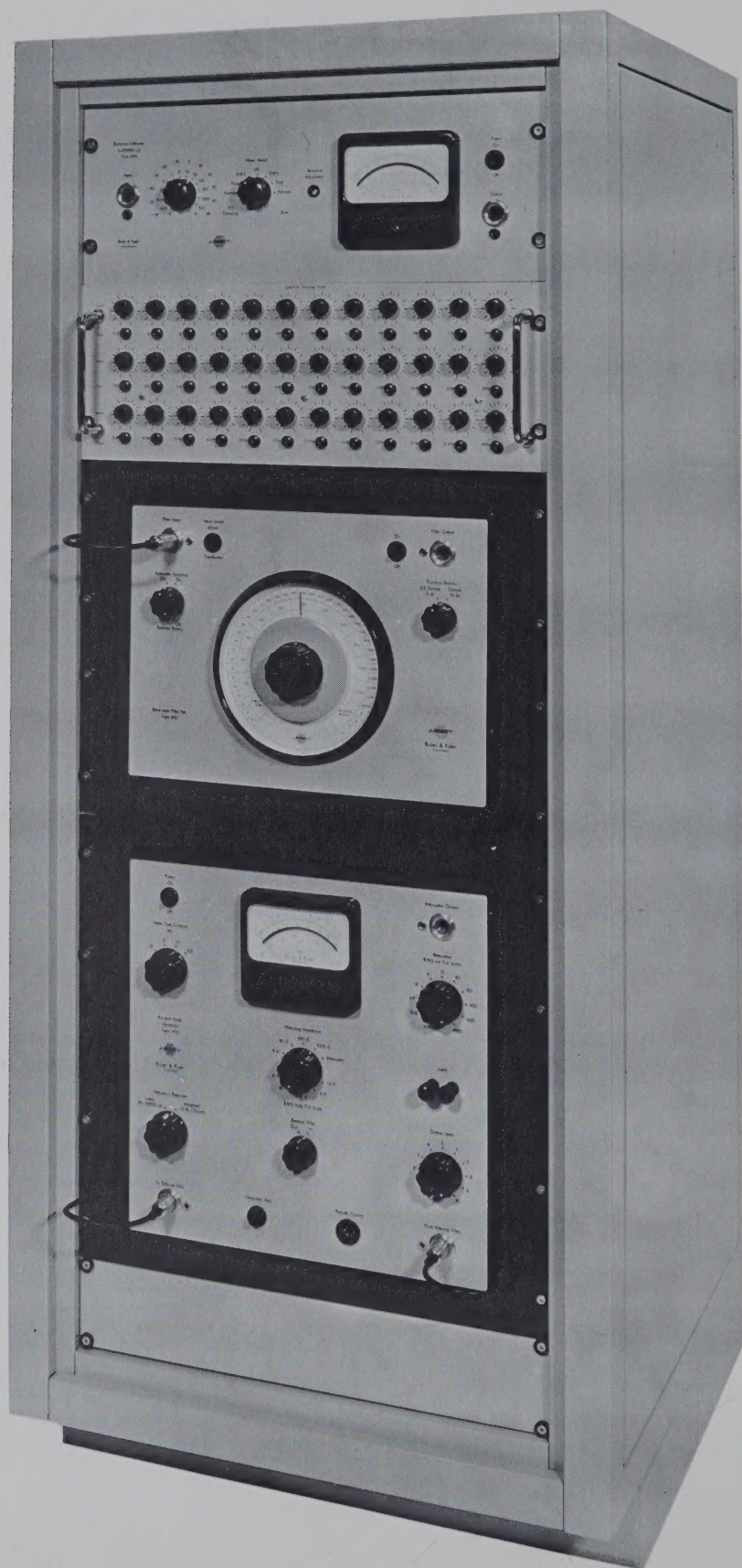
MODEL 1612/S2 SPECTRUM SHAPER

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I N T R O D U C T I O N

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The instruments described in this brochure are modifications which are offered on the 1612 1/3 octave filter set. The modifications are listed below:

<u>TYPE</u>	<u>MODIFICATION</u>	<u>PRICE</u>
<u>1612/S1</u> PARALLEL FILTER	Addition of 36 output amplifiers so that all filter outputs are available at the rear of the instruments.	\$3270.00
<u>1612/S2</u> SPECTRUM SHAPER	Addition of 36 output amplifiers and 36 level controls all re-combined to provide a shaped spectrum.	\$3470.00
<u>1612/S3</u> PARALLEL ANALYZER	Addition of 36 output amplifiers and detectors suitable for driving multi-channel oscillograph galvanometers.	\$5480.00

B & K INSTRUMENTS, INC.

1612 S 1 PARALLEL FILTER

1. GENERAL

The 1612/S1 Parallel Analyzer is a 36 channel $1/3$ Octave Filter Set which can separate a broad band random noise signal into 36 $1/3$ octave bands in the frequency range from 10 cps to 44 Kcs. After separation the signals are amplified and made available at a multi pin rear connector, The 1612 S 1 can also be used as a $1/3$ octave analyzer.

2. DESCRIPTION

The 1612 S 1 Spectrum Shaper is a modified Bruel & Kjaer 1612 $1/3$ octave analyzer. The input connection operates directly or through an input transformer as selected by a front panel switch. In the direct connection an input signal of 1V RMS is required to operate the filters at their optimum level and the source impedance should be 25 ohms or lower. In the transformer coupled mode, the input level should be 10 V RMS and source impedance should be no greater than 2000 ohms.

The input signal drives 33 one third octave filters in parallel. The internal filters have center frequencies from 25 to 40,000 cps, however, a rear connector is available to connect the Bruel & Kjaer 1620 Extension Filter Set and this provides three additional channels at center frequencies of 12.5, 16, and 20 cps. The 1612S1 will operate with or without the 1620 Extension Filter Set.

Each filter output is connected to a two transistor emitter follower amplifier which provides an impedance change from the relatively high filter impedance down to approximately 10,000 ohms. The amplifiers are arranged six channels on one plug-in printed circuit card and six cards are mounted on the rear of the 1612 chassis. The original case of the 1612 has been extended back to accommodate the amplifiers and is supplied with a KS0003 rack mounting frame. The 36 amplifier outputs are terminated in a rear connector. The scanning switch, originally connected to the filter outputs, is re-wired to the outputs of the 36 amplifiers. A separate amplifier is provided to isolate the scanning analyzer output from the selector switch and it obtains power from the input amplifier or the auxiliary power socket as in a standard 1612 filter. A regulated 12 V DC supply provides power to 36 amplifiers and is energized from 115V 60 cps power connection on the rear of the cabinet and a front panel switch turns the power on/off. The weighting networks (ABC & Linear) are disconnected and are not available externally.

3. OPERATING LEVELS

The nominal input to the 1612 S 1 is 1 V RMS at which level, the amplifiers can operate with peak amplitudes up to 4.2 volts. This allows signals with crest factors up to 4 to be analyzed. Signals with lower crest factors can be operated at higher levels and sinusoids of 3 volts amplitude will not be clipped and will not affect the passband characteristics of the individual filter sections.

4. SPECIFICATIONS 1612/S 1

Frequency Range:	22 - 45,000 cps in $33 \frac{1}{3}$ octaves mounted inside the instrument. 11 - 45,000 cps when the Bruel & Kjaer Model 1620 is added externally ($36 - \frac{1}{3}$ octaves)
Center frequencies:	ISO (preferred) 25, 31.5, 40 50 cps -- 40 Kcs.
Filter type :	3 n
Input level:	1 V RMS
Max input level:	3 V RMS
Output for 1 V RMS input:	0.95 V
1/3 octave outputs:	36
Scanner outputs:	1
Maximum load :	10 K ohm
Cross talk :	less than 55 db
Scanner operation:	Manual from front panel knob or remote by electro-magnetic stepper.
Stepper drive requirement:	24 V 180 m A

Dimensions:	11" high x 15" wide x 13" deep
Dimensions when rack mounted:	14" high x 19" wide x 13" deep
Accessories supplied with unit:	3) JP 0018 shielded plugs 1) AO0008 connector for battery operation of scanning mode isolation amplifier 1) AO0002 control cable for remote scanning from B & K 2305 Level Recorder.
Price:	\$3270.00

B & K INSTRUMENTS, INC.

1612 S 2 SPECTRUM SHAPER

1. GENERAL

The 1612/S2 Spectrum Shaper is a 36 Channel $1/3$ Octave Combination Filter which can separate a broad band random noise signal into 36 $1/3$ octave bands in the frequency range from 10 cps to 44 Kcs. After separation the signals are amplified and recombined. Each signal channel is fitted with an attenuator which allows the $1/3$ octaves to be adjusted so that a shaped spectrum of random noise is obtained at the output.

The Spectrum Shaper can also be used as a $1/3$ Octave Analyzer.

2. DESCRIPTION

The 1612/S2 Spectrum Shaper is a modified Bruel & Kjaer 1612 $1/3$ Octave Analyzer. The input connection operates directly or through an input transformer as selected by a front panel switch. In the direct connection an input signal of 1V RMS is required to operate the filters at their optimum level. The source impedance should be 25 ohms or lower. In the transformer coupled mode, the input level should be 10V RMS and source impedance should be no greater than 2000 ohms.

The input signal drives 33 one third octave filters in parallel. The internal filters have center frequencies from 25 to 40,000 cps, however, a rear connector is available to connect the Bruel & Kjaer 1620 Extension Filter Set and this provides three additional channels at center frequencies of 12.5, 16, and 20 cps. The 1612/S2 will operate with or without the 1620 Extension Filter Set.

Each filter output is connected to a two transistor emitter follower amplifier which provides an impedance change from the relatively high filter impedance down to approximately 10,000 ohms. The amplifiers are arranged six channels on one plug in printed circuit card and six cards are mounted on the rear of the 1612 chassis. The original case of the 1612 has been extended back to accommodate the amplifiers, however, the cabinet can be rack mounted with the usual B & K KS 0003. The 36 amplifier outputs are terminated in a rear connector. The scanning switch, originally connected to the filter outputs, is re-wired to the outputs of the 36 amplifiers. A separate amplifier is provided to isolate the scanning analyzer output from the selector switch.

A regulated 12V DC supply provides power to 36 amplifiers and is energized from 115V 60 cps power connection on the rear of the cabinet. The weighting networks (ABC & Linear) are disconnected. A front panel switch turns the power on/off. The 1/3 octave scanning mode amplifier obtains power from the drive amplifier or the auxiliary connector.

A separate panel is used to mount the 36 output level controls and this is usually mounted directly above or below the filter unit. Each level control is a log taper potentiometer with reverse characteristics, thus, the output is maximum when the control is fully CCW and the channel is attenuated by turning the control clockwise. The slider of each level control is coupled by a small capacitor to a test point. A summing resistor is also connected from the potentiometer slider to a summing bus bar and the summed output

is brought out to a rear connector. The maximum output of 1V RMS input is approximately 50 mV.

3. COMPONENT PARTS

The 1612/S2 consists of:

- 1 - modified Bruel & Kjaer 1612
- 1 - KS 0003 Rack Mount Adaptor
- 1 - Summing Panel
- 1 - Power Cord
- 1 - Accessory Box
- 1 - Instruction Manual

4. OPERATION WITH A BRUEL & KJAER 1402 RANDOM NOISE GENERATOR

The Bruel & Kjaer 1402 Random Noise Generator is a broad band white & pink noise generator which provides an excellent noise source for the 1612/S2.

The 1402 external filter connection provides the correct driving impedance for the direct connection of the filter inputs. The summed output is connected back to the 1402 external filter connection and the shaped signal is amplified by the 1402 output amplifier.

The 1402 produces random noise with gaussian amplitude distribution. At equal 1/3 octave attenuator settings the 1612/S2 summing panel will have an output in which the energy per 1/3 octave band will increase with frequency at +3 db/octave. An internal filter is included in the 1402 to slope the output

at -3 db per octave to obtain an equal energy / 1/3 octave condition.

The 1402 is equipped with a relay which stops the random noise generator. This relay can be remotely controlled from the 2305 Graphic Level Recorder or any other control source and controlled bursts of random noise can be generated. Further details are given in the 1402 Instruction Manual.

5 . USE OF THE EXTENSION FILTER SOCKET FOR REAR CONNECTED INPUT

One JP 0019 Adaptor is supplied with the 1612/S2 accessories. If the 1620 Extension Filter Set is not used this adaptor may be inserted into the extension filter socket. A standard JP 0018 will now plug into the center of this adaptor to provide a rear input connector.

6 . ROLL OFF CHARACTERISTICS

The frequency response shown in SK-200 shows the notch characteristics of the 1612S. The 1612S2 is often used as a spectrum shaper to simulate the attenuation characteristics of a building wall. This requires an output which has increasing attenuation with frequency and the notch characteristic does not define the instrument capability. SK-247 shows two roll off settings. Fig. 1 shows the 1/3 octave outputs from 100 to 1000 cps reducing at 4 db/1/3 octave or 40 db per decade. Fig. 2 shows a similar test at 2000 - 5000 cps with the roll off set at 10 db/1/3 octave or 90 db per decade.

7. SPECIFICATIONS 1612 /S2

Frequency range	22 -45,000 cps 10 - 45,000 cps when used with 1620 extension filter set
Band Pass Filters	1/3 octave to ASA Standards 1.6 - 1960
Selectivity of individual filters	More than 40 db at 1 octave from center frequency
Source resistance of input signal	Must be less than 2000 ohms for transformer coupled input. 20 ohms or less for direct input.
Input voltage	1 volt direct 10 volts transformer coupled
Selective output	1/3 octave from selector switch 1 volt amplitude
Summed output	40 mV at summing junction
Signal to noise ratio	60 db
Scanning method	Manual from front panel or remote stepping from 28V supply
Stepper load	28 volts 180 mA
Summing adjustments	36-33 used with internal filters 3 used with 1620 extension filter set

Accessories

3)JP-0018 Shielded Plugs

1) AQ-0002 Control Cable

1) AQ-0008 Battery Connector

1) KS-0003 Rack Mounting Adapter

Demensions:

Filter Unit

16" wide x 12" high x 14" deep

19" wide x 14" high x 14" deep

when mounted in KS0003 rack mount
adapter.

Summing Panel

19" wide x 7" high x 8" deep

PRICE.....\$3470.008. APPLICATIONS8.1 SPECTRUM ANALYSIS

The 1612/S 2 can be used with the 2603, 2604 or 2107 as an external filter. When coupled to the 2305 the combined system will perform a conventional 1/3 octave analysis. It will not operate as a 1 octave analyzer.

8.2 SPECTRUM SHAPING

The 1612/S2 can be used as an external filter with the 1402 to make a shaped spectrum of random noise or with the 2603, 2604 or 2107 to make a shaped frequency response characteristic.

2a: 1402 + 1612/S2 (Shaped Random Noise)

The 1612/S2 is connected between the external filter posts of the 1402 and is used to shape the frequency distribution of random noise. This arrangement is used to simulate noise spectra for the acoustic excitation of aircraft or missile components and structures. It is also used to generate an equivalent noise source especially where the true source is difficult or too costly to operate as a sustained noise generator. In this case the analysis of the actual noise source can be made on the spectrum shaper prior to the simulation.

8.3 2603 + 1612/S2 (Simulation of a structural member)

This arrangement is used to simulate the acoustical properties of structural component such as a partition wall. The specimen partition can be analyzed by using the 1612/S2 as a sequential 1/3 octave filter to shape random noise into 1/3 octave bands and so drive a power amplifier and loud speaker on the source side of the test partition. Measurements are made with two microphones, one on the source side and one on the listening side and subtracting the two readings. A typical set up is shown in SK-248 and the microphone switching is accomplished by a 4408 two channel microphone selector. This method allows the customer to use an inexpensive

power amplifier and loud speaker because the frequency response of the loud speaker need only be flat in a $1/3$ octave band. Deterioration of speaker performance is compensated by the measurement method. A 40 watt power amplifier and a good reflex cabinet can provide sound pressures above 110 db SPL.

Once the sound transmission characteristics of the specimen are established, the 1612/S2 can be set up by driving it from an oscillator or a random noise generator and the $1/3$ octave levels adjusted using the 2603 as a voltmeter to measure the $1/3$ octave outputs.

The 1612/S2 is then connected to the external filter connections of the 2603 and the partition is simulated electrically. If tape recordings of a sound source (cocktail party, machinery, etc.) are now played into the 2603, the output will be similar to what an observer would hear on the listening side of the partition.

Referring to the instruction manual which is enclosed with this random noise, SK-248 shows the signal attenuation through the 1612/S2 when maximum roll off is required. Roll off at 36 db per octave can be obtained over a range of 60 db. This is a very important capability for structure simulation and is greatly in excess of any spectrum shape that would be

encountered in practice.

8.4 2603 + 1612/S2 (Subjective or listening jury tests)

Appliance manufacturers are concerned with the noise output from domestic appliances. They are faced with the difficult task of making a machine which is not acoustically objectionable. This can be accomplished by either building a completely quiet machine or eliminating the objectionable portion of the noise spectrum. If the operating noise of the appliance is played through a 1612/S2 into an HA-10 headset, the listener can attenuate the noise in 1/3 octave bands to establish the effect of reducing specific noise components so that the appliance becomes acceptable. This is less costly than quieting the whole mechanical system.

9. WHAT ELSE CAN BE ADDED TO THE 1612/S2

The 1620 Extension Filter Set can be added to the 1612/S2 to operate down to 12.5 cps center frequency.

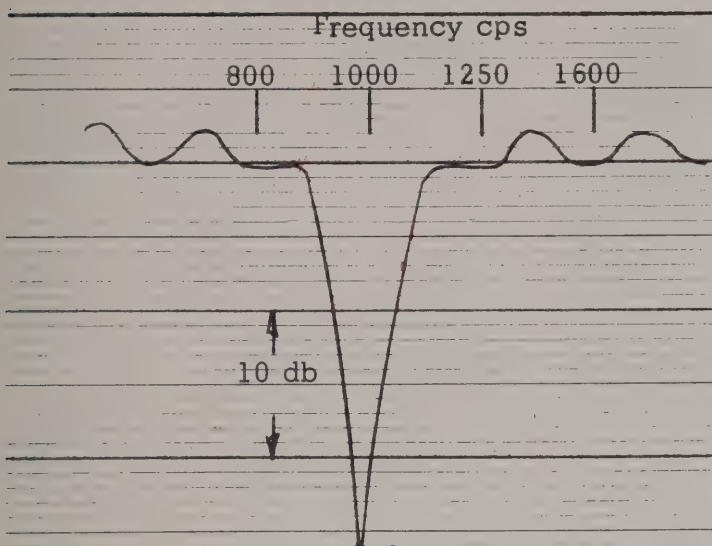
The 1402, 1612/S2, 1620 and 2416 can be supplied in a single rack unit as in the photograph in the instruction manual. This provides a complete shaped random noise source for about \$5700.00

The LF1, 2 and 3 active filters can be added to the system to go down down to 1.5 cps with 1 octave bands at 2, 4, and 8 cps and 1/3 octave bands

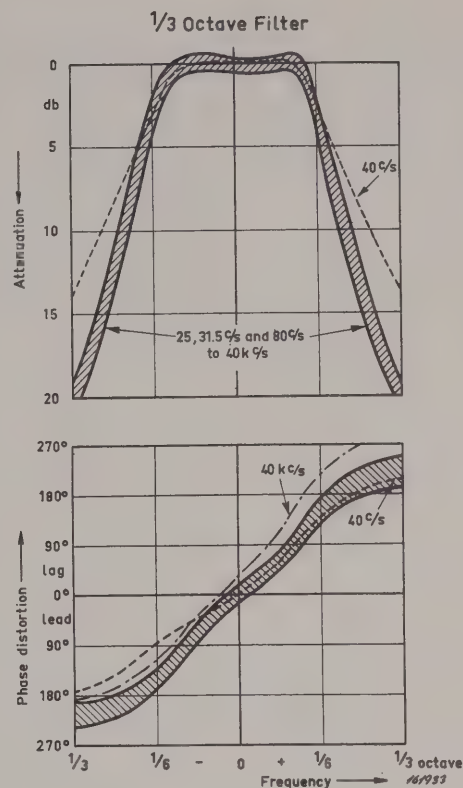
up to 20 Kcs. The top 3 sections at 25, 31.5 and 40 Kcs are traded off in this case to provide for the low frequency units.

The 1024 Sine Random Generator can be used as a signal source to generate broad band random noise shaped spectra or to generate shaped swept narrow band spectra.

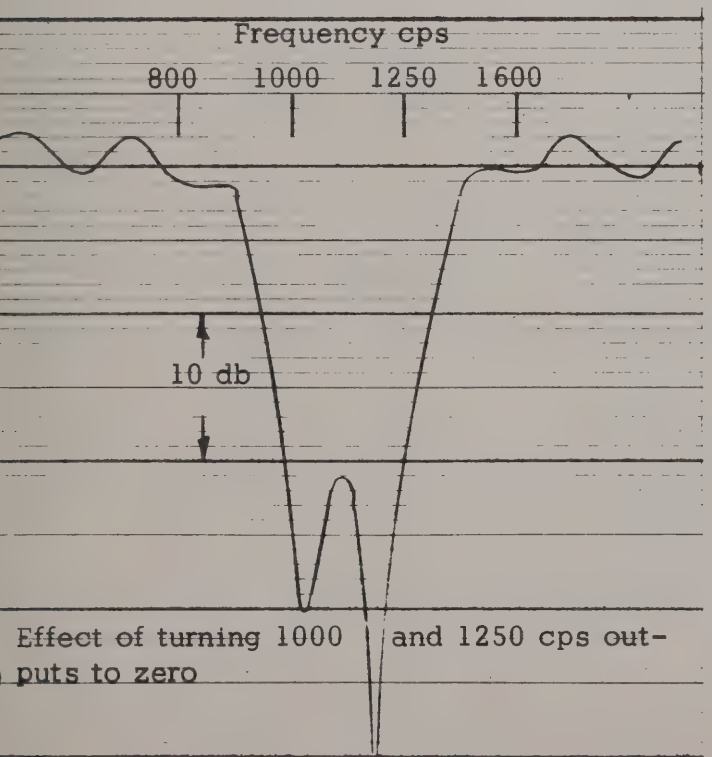
FREQUENCY RESPONSE CHARACTERISTICS OF 1612S SPECTRUM SHAPER



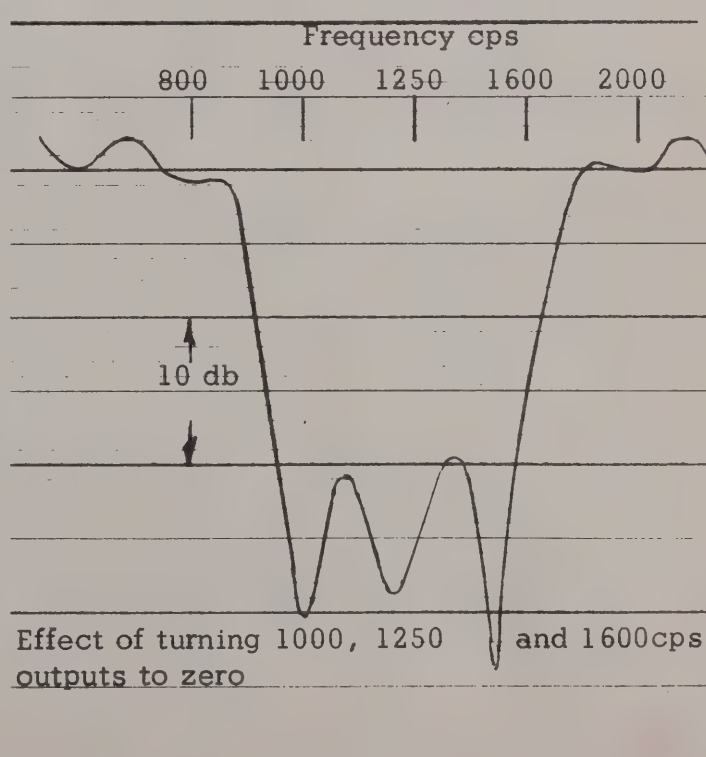
Effect of turning 1000 cps output to zero



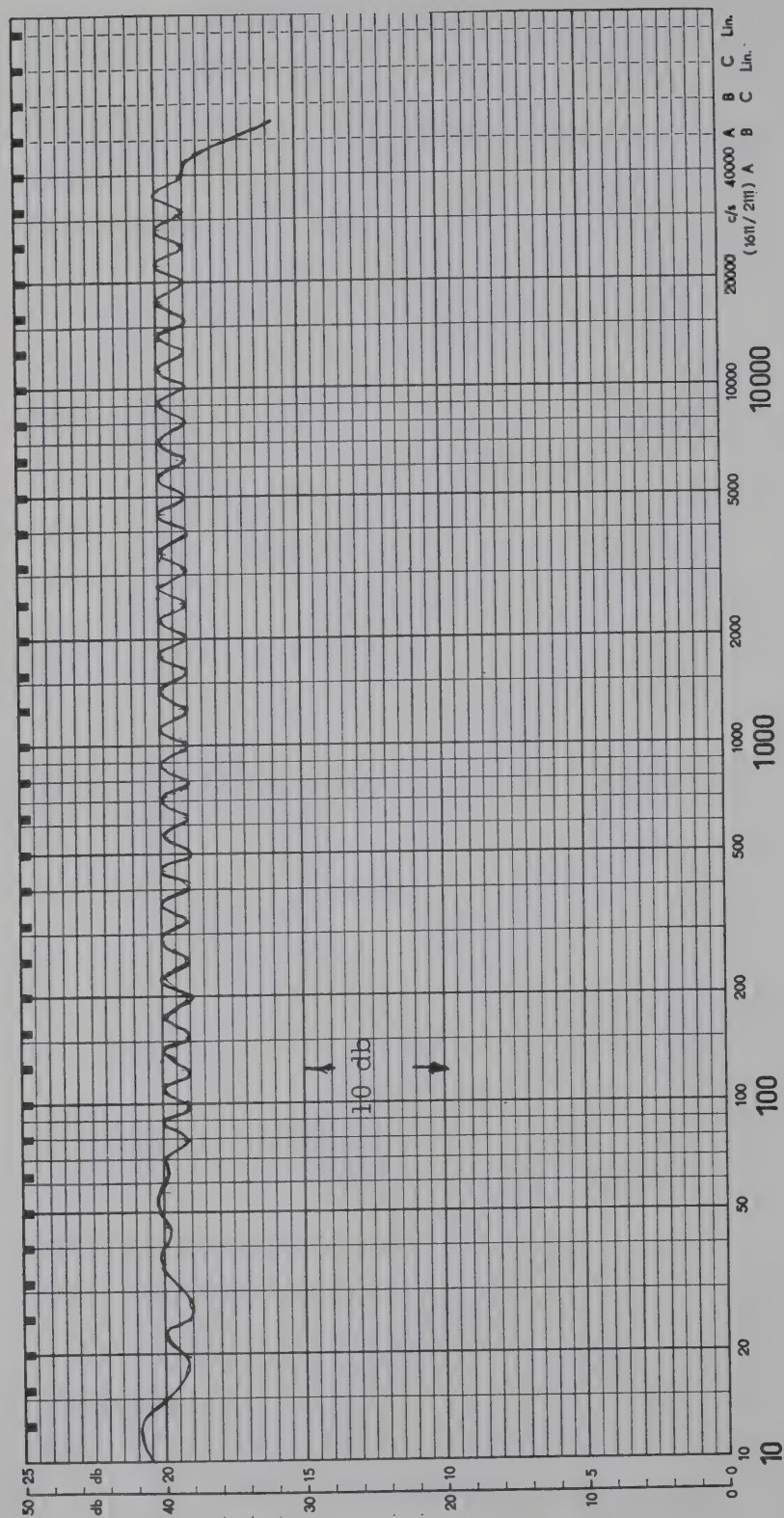
PHASE SHIFT CHARACTERISTICS OF 1/3 OCTAVE FILTERS.



Effect of turning 1000 and 1250 cps outputs to zero



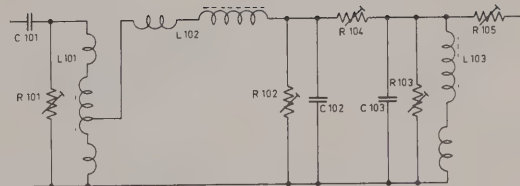
Effect of turning 1000, 1250 and 1600 cps outputs to zero



FREQUENCY RESPONSE OF 1612/S/2 WITH 1620 EXTENSION FILTER SET

All output controls at maximum

Filter No.	Frequency c/s	L 101, 102 and 103 H	C 101- 103 nF	R 101 k Ω .	R 102 k Ω .	R 103 k Ω .	R 104 k Ω .	R 105 k Ω .
ZS 0146	12.5	80	2000				250	300
	16	63	1600				"	"
	20	50	1250				"	"
ZS 0048	25	40	1000				300	"
ZS 0049	31.5	31.5	800				"	"
ZS 0029	40	25	630				"	"
	50	20	500				"	"
ZS 0030	63	16	400				"	150
	80	12.5	315				"	"
ZS 0031	100	10	250			300	"	"
	125	8	200			"	"	"
ZS 0032	160	6.3	160			"	"	"
	200	5	125 (800)			"	"	"
ZS 0150	250	4	100			"	"	"
	315	3.15	80			"	"	"
ZS 0151	400	2.5	63			"	"	"
	500	2	50			"	"	"
	630	1.6	40			"	"	"
	800	1.25	315			"	"	"
ZS 0152	1000	1.0	25	500		150	"	"
	1250	0.8	20	300	500	"	"	"
	1600	0.63	16	"	"	"	"	"
	2000	0.5	12.5	"	"	"	"	"
ZS 0153	2500	0.4	10	"	"	"	"	"
	3150	0.315	8	"	"	"	"	"
	4000	0.25	6.3	"	"	"	"	"
	5000	0.2	5	"	"	"	"	"
ZS 0039	6300	0.16	4	"	"	"	"	"
	8000	0.125	3.15	"	"	"	"	"
	10000	0.1	2.5	"	"	"	"	"
	12500	0.08	2	"	"	"	"	"
	16000	0.063	1.6	"	"	"	"	"
ZS 0142	20000	0.05	1.25	"	"	"	"	"
	25000	0.04	1.0	"	"	"	"	"
	31500	0.0315	0.8	"	"	"	"	"
	40000	0.025	0.63	"	"	"	"	"



SK217
TABLE OF FILTER COMPONENT
VALUES

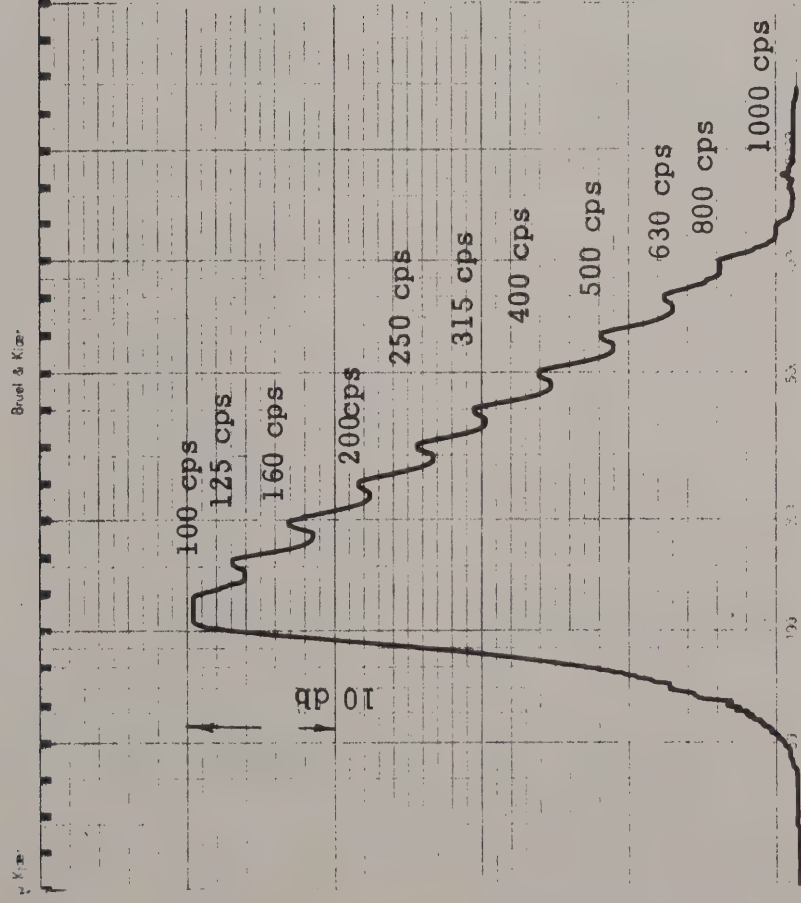


Fig . 1 100 cps to 1 Kcs rolling off
at -4 db per 1/3 octave
(-12 db per octave)

Note: All other 1/3 Octaves turned off

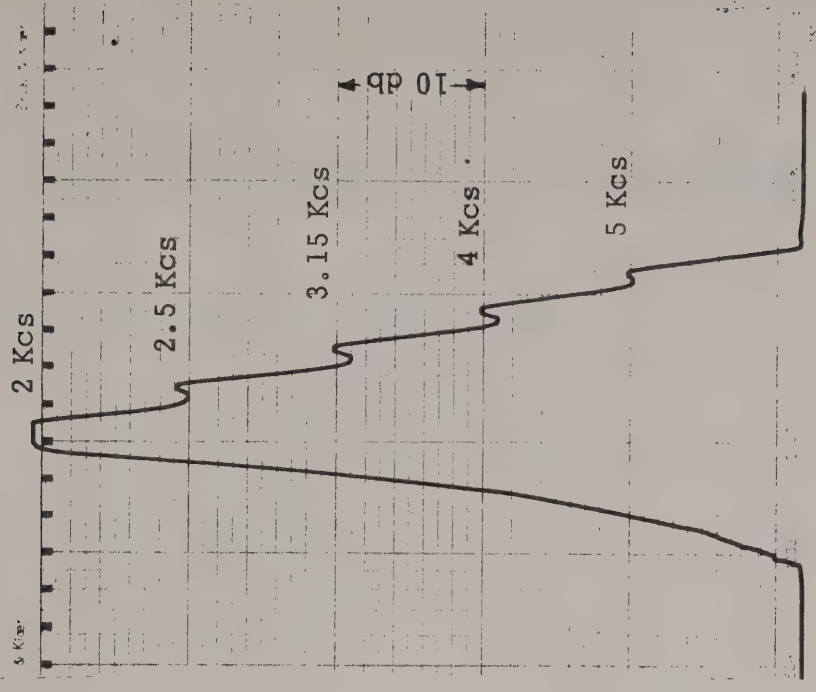
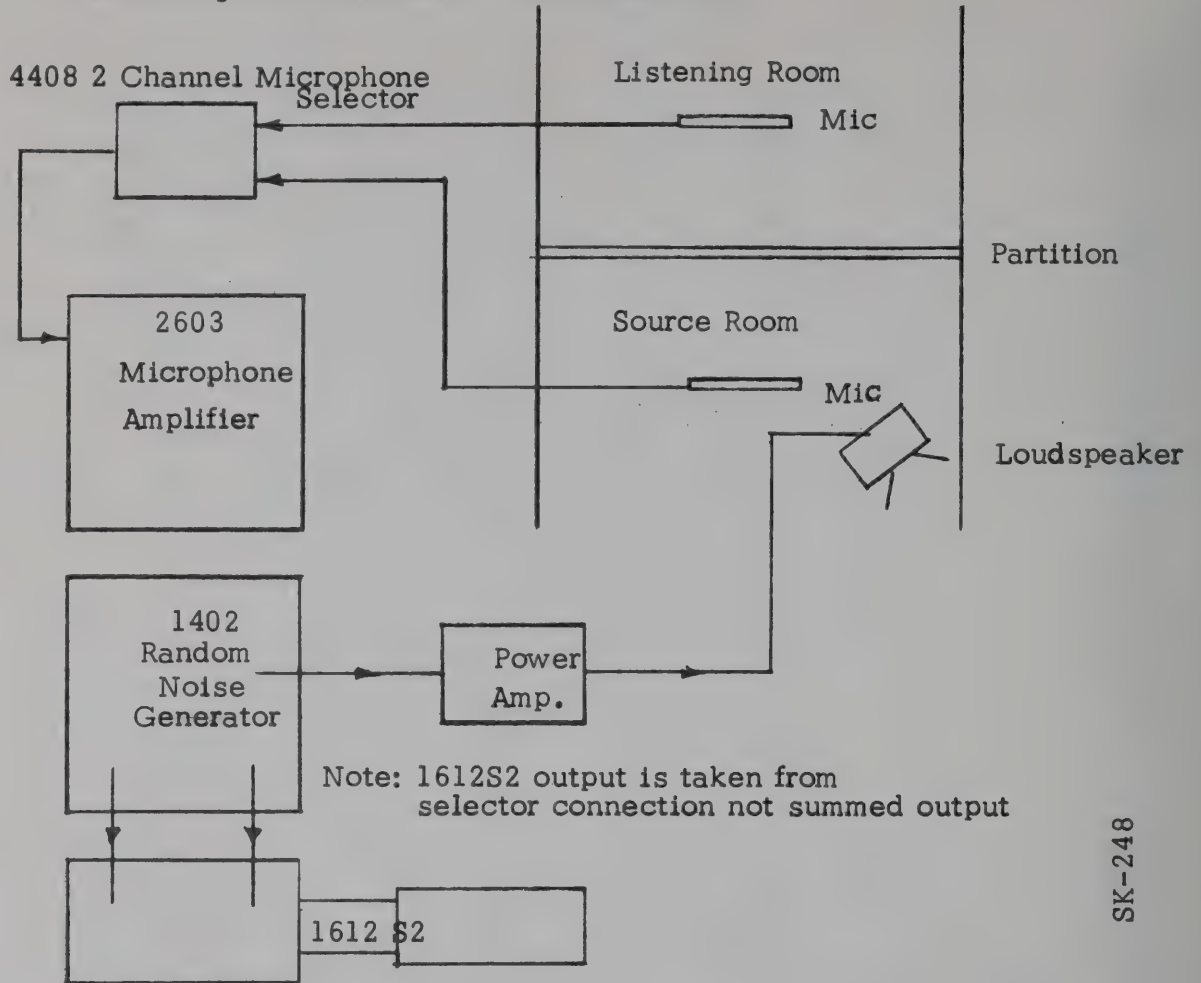


Fig. 2 2 Kcs to 5 Kcs rolling off
at 10 db per 1/3 octave
(30 db/octave)

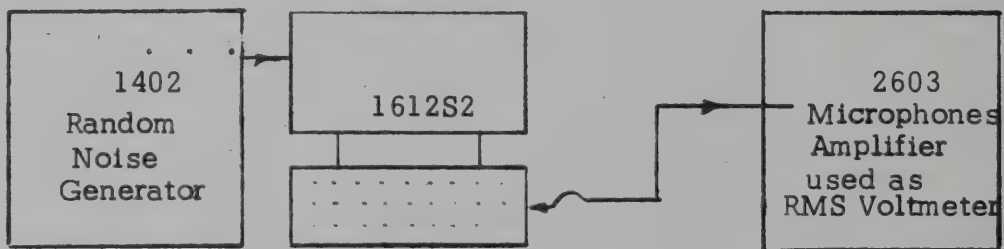
SIMULATION OF A PARTITION WALL

Phase 1 - Measuring the transmission characteristics

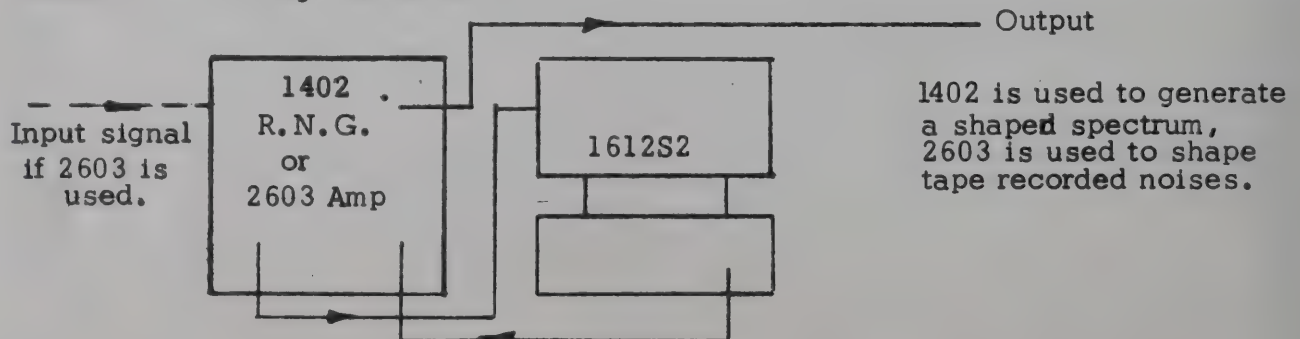


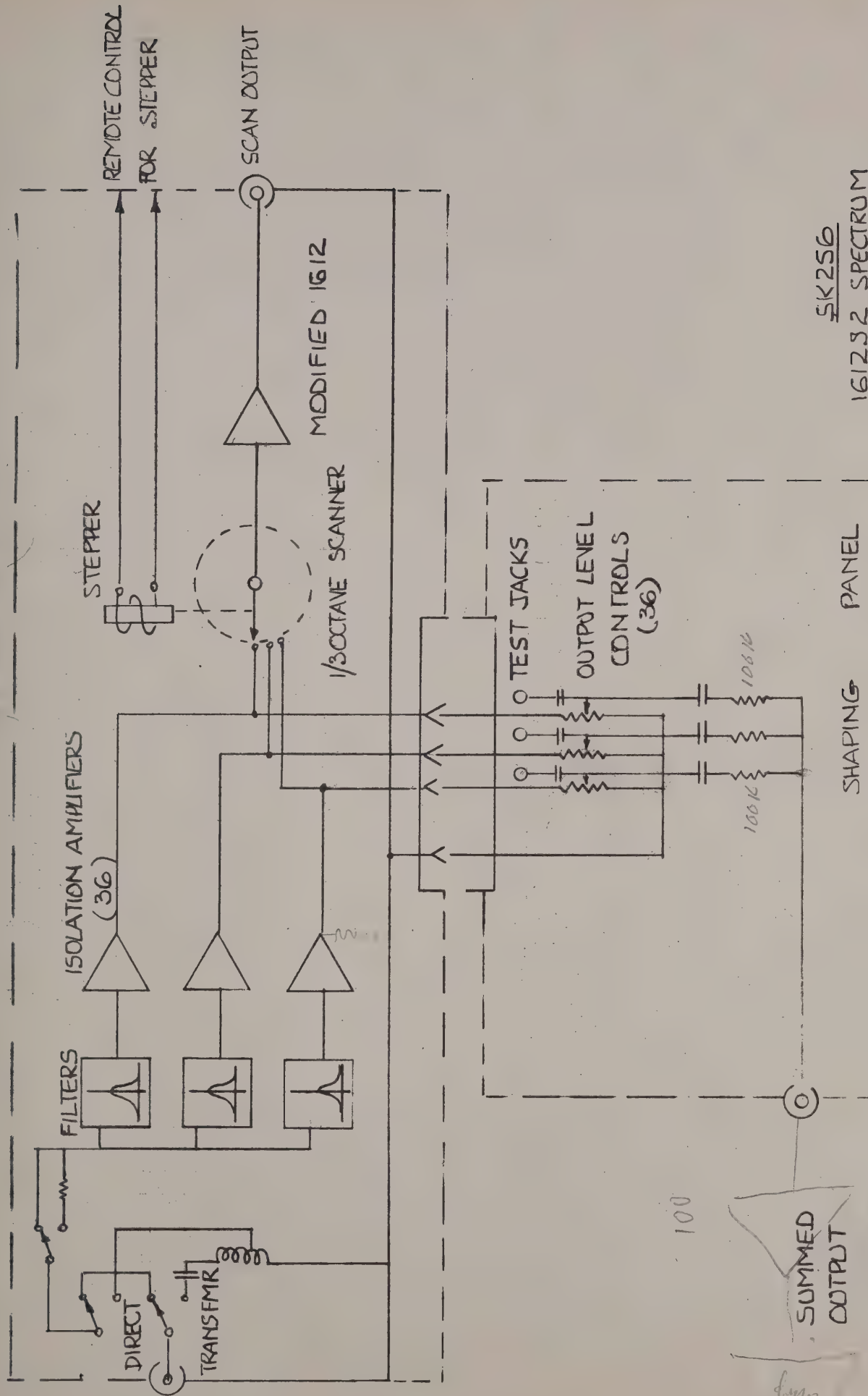
SK-248

Phase 2- Setting up the 1612S2



Phase 3- Using the Simulator





SK256
161232 SPECTRUM
SHAPEK

B & K INSTRUMENTS, INC.

1612 S 3 PARALLEL ANALYZER

1. GENERAL

The 1612 S/3 Parallel Analyzer is a 36 channel $1/3$ octave filter set which can separate a broad band noise signal into 36 $1/3$ octave bands in the frequency range from 10 cps to 44 Kcs. After separation the signals are amplified and detected. The detected output is filtered and used to operate oscillograph galvanometers to produce a real time amplitude history in $1/3$ octaves. The Parallel Analyzer can also be used as a $1/3$ octave analyzer.

2. DESCRIPTION

The 1612 /S 3 Parallel Analyzer is a modified Bruel & Kjaer 1612 $1/3$ octave filter set. The input connection operates directly or through an input transformer as selected by a front panel switch. In the direct connection an input signal of 1 V RMS is required to operate the filters at their optimum level. The source impedance should be 25 ohms or lower. In the transformer coupled mode, the input level should be 10V RMS and source impedance should be no greater than 2000 ohms.

The input signal drives 33 one third octave filters in parallel.

The internal filters have center frequencies from 25 to 40,00 cps, however, a rear connector is available to connect the Bruel & Kjaer 1620 Extension Filter Set and this provides three additional channels at center frequencies of 12.5, 16 and 20 cps. The 1612/S3 will operate with or without the 1620 Extension Filter Set. •

Each filter output is connected to a two transistor emitter follower amplifier which provides an impedance change from the relatively high filter impedance down to approximately 10,000 ohms. The amplifiers are arranged six channels on one plug in printed circuit cards and six cards are mounted on the rear of the 1612 chassis. The original case of the 1612 has been extended back to accommodate the amplifiers and the rack mounting hardware is included with the unit. The 36 amplifier outputs are terminated in a rear connector. The scanning switch, originally connected to the filter outputs, is rewired to the outputs of the 36 amplifiers, and a separate amplifier is provided to isolate the scanning analyzer output from the selector switch.

A regulated 12 V DC supply provides power to 36 amplifiers and is energized from 115V 60 cps power connection on the cabinet and is controlled from a front panel switch. The scanning isolation amplifier obtains its power from the input drive amplifier or the external battery connector as in the standard 1612.

The output of the separate amplifiers is brought to a rear multi pin connector and the unit is identical to the 1612 S 1 and the portion of the 1612.

A separate chassis is used to house the detector circuits. Each detector consists of a driver transistor and a full wave voltage doubler which feeds into an R. C. filter. The output of the R. C.

Filter is fed via a sensitivity control to the output connector. All 36 detectors are contained in the single chassis.

The detector circuit has been designed to operate directly into the galvanometer coil of an optical oscillograph. The standard arrangement is intended to deliver 20 uA at full output level into a galvanometer of 20 to 100 ohms. A shunt damping resistance of 350 ohms is built into the circuit but other values can be supplied. The galvanometer circuit is off ground but is shunted to ground by the detector filter capacitors. Using a typical galvanometer of 10 uA/in sensitivity, full scale deflection is 2 inches. This type of galvanometer should have a frequency response of at least 50 cps which is more than adequate for the 1/3 octave amplitude signals. The signal is detected and the galvanometer frequency response is only concerned with the rate of change of the signal level.

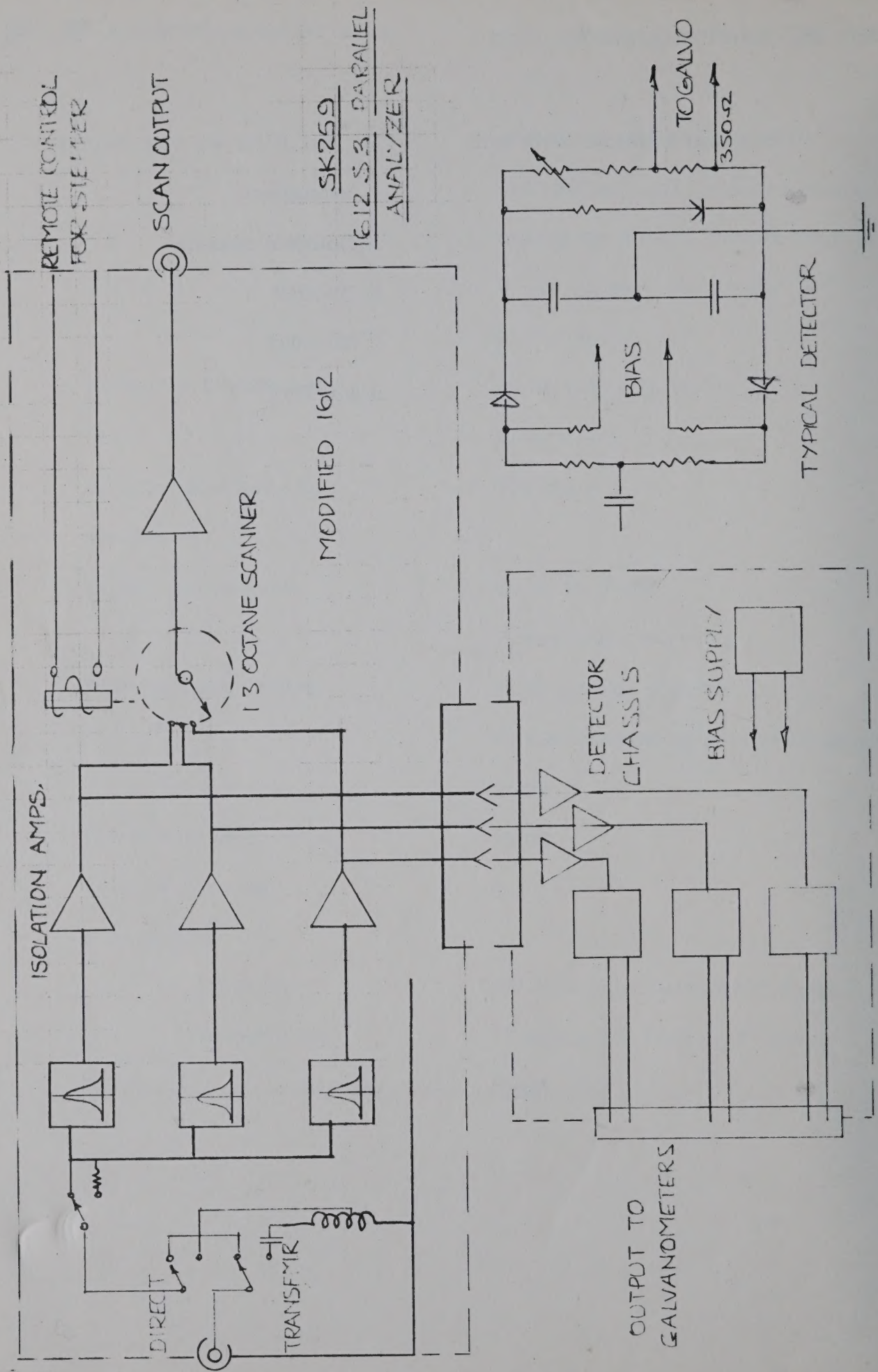
3. SPECIFICATION 1612/S3

Frequency range	22 - 44,000 cps in 1/3 octaves (33) 11 - 40,000 cps in 1/3 octaves (36) when using the 1620 extension filter set.
Selective channels	36
Center frequencies	15.0 (preferred)
Power	175 V 60 cps
Input	1 V RMS requires 25 ohm source

	impedance or less. 10V RMS (transformer input) requires source impedance of 2000 ohms or less.
Output	0 - 20 uA max. sensitivity 0 - 10 uA min.
Output for 1V RMS input (sine)	20 uA max. adjustable 10 uA min.
Galvanometer damping resistance	350 ohms
Typical galvanometer	C. E. C. 7-342 Honeywell M-100-350
Detector time constant	0.15 seconds standard . Can be changed by plug in component board
Detector dynamic range	30 db
Detector linearity	$\pm 1\%$
Dimensions:	
Filter unit	14" high x 19" wide x 13" deep
Detector unit	7" high x 19" wide x 12" deep
PRICE:	<u>\$5480.00</u>

Components shipped with unit:

- 1) 1612 filter set with 36 output
amplifiers
- 1) Detector chassis
- 3) JP-0018
- 1) AO-0008
- 1) AO-0002





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